9 Likely Ground Movements

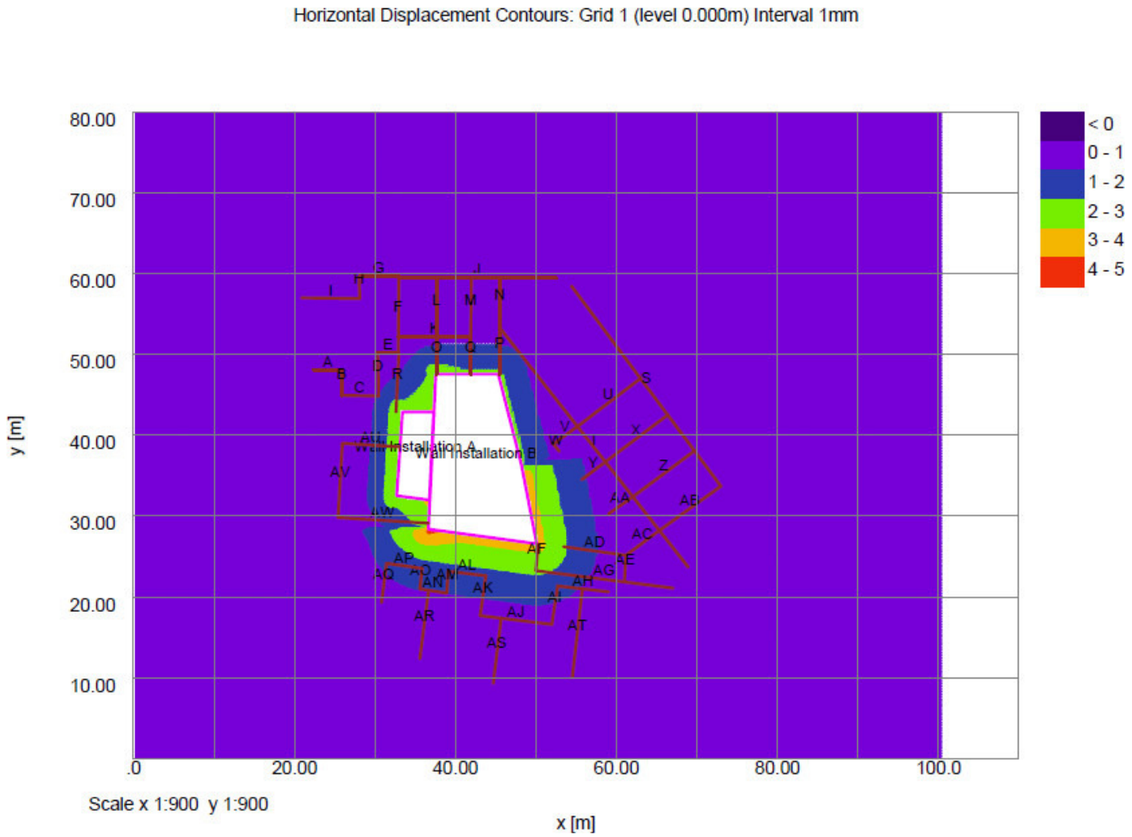
The key construction activities that will result in ground movement during the works are:

1. Demolition
2. Installation of Underpins
3. Excavation
4. Construction of new building

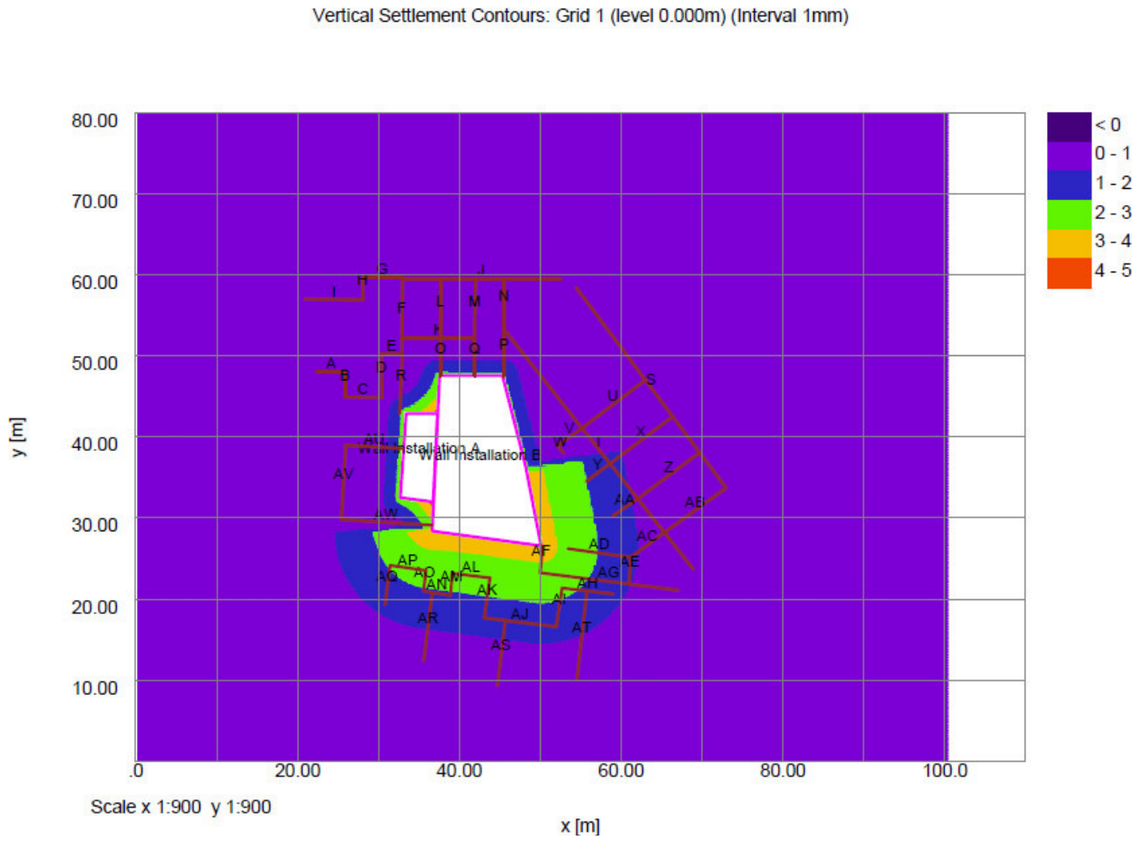
The amount of ground movement caused by these activities relates to the ground conditions, together with the care and sequence with which the works are carried out. This analysis is based on the sequence of construction described previously, should the Contractor propose to carry out the works in a different sequence to that assumed in our design then a further assessment of the predicted movement will be required, and the proposal only accepted if there is no significant change to the scale of predicted movement.

All projects which involve an appreciable level of excavation will cause a degree of movement and the GEA analysis has helped to quantify this for the project. Generally, the ground behind the retaining wall will tend to move vertically down and horizontally toward the excavation on all sides. The maximum predicted movements are illustrated below.

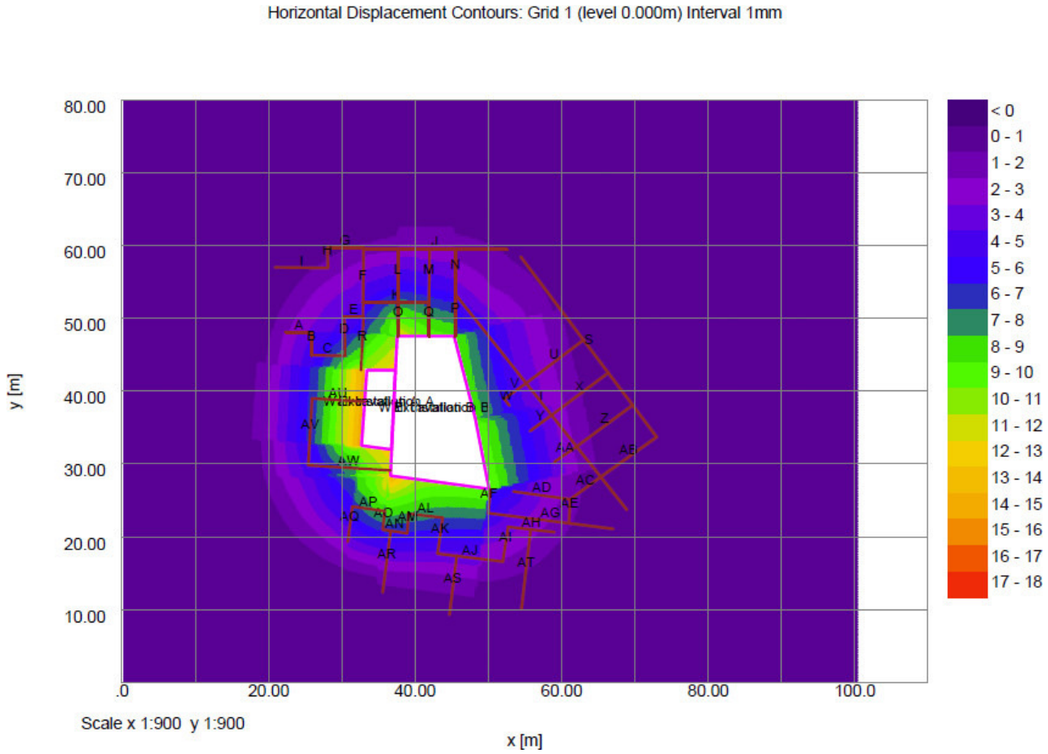
The results predicted have resulted from a carefully considered iterative process, with the design and assumed sequence of construction has been developed to help to reduce the amount of overall movement.



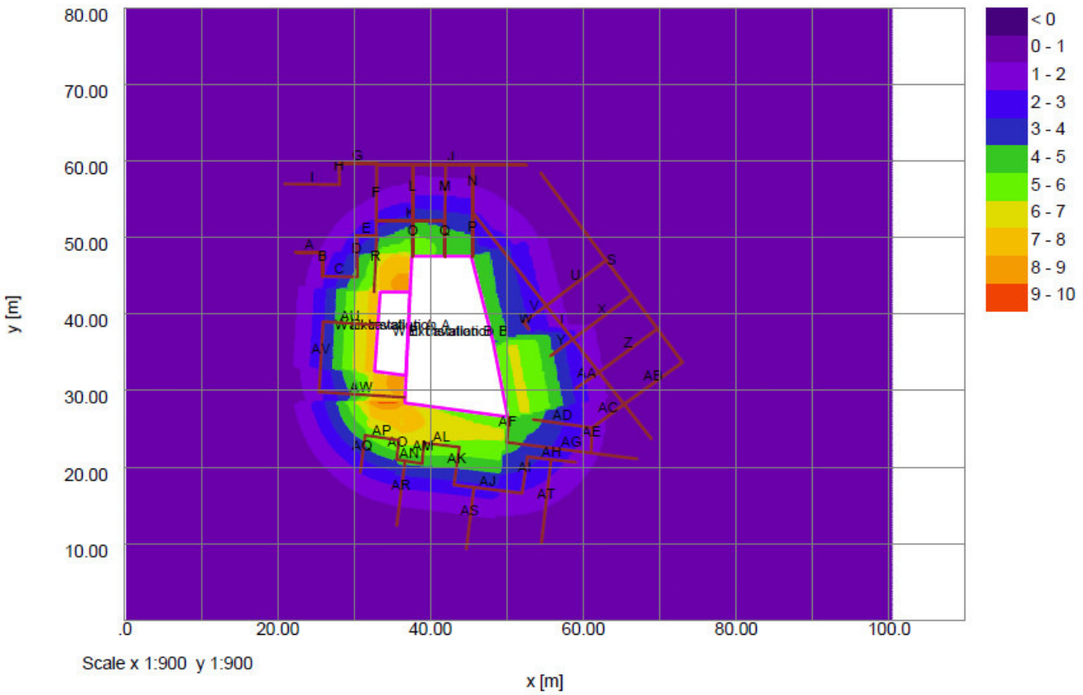
Horizontal Displacement after Install of Wall



Vertical Displacement after Install of Wall



Horizontal Displacement after Excavation



Vertical Displacement after Excavation

10 Discussion of Predicted Ground Movements and Potential Damage

10.1 Discussion

The Contractor will be made aware of the care he needs to take in carrying out the works and how the likely movements depend on the sequence of works. Should the Contractor propose to carry out the works in a different sequence to that assumed in our design then a further assessment of the predicted movement will be required, and the proposal only accepted if there is no significant change to the scale of predicted movement.

GEA's analysis has indicated that the maximum vertical settlements and horizontal movements that will result from the new retaining wall construction are less than 5 mm. Furthermore, the analysis has indicated that the maximum vertical settlements and horizontal movements that will result from the combined effect of the retaining wall installation and excavation are around 15 mm or less. The amount of movement will then reduce with distance away from the new basement. These ground movements will extend under the adjoining properties along Kings Cross Road, Derby Lodge, and Britannia Street. The cracks which are predicted within the GEA report (Appendix D) show that most walls will fall within the 0 - Negligible and 1 - Very Slight categories as measured against the Burland Scale (table can be seen on the left) whilst three walls of sensitive structures may result in Category 2 'slight' damage. To reduce the damage category of these sensitive structures to Category 1 – Very Slight a monitoring strategy is recommended for the proposed construction, the horizontal limits outlined in The Appendix D should be incorporated into the strategy in order to limit the predicted movement to Category 1, Very Slight. It is recommended that movement monitoring is carried out on all structures prior to and during the proposed basement construction. Whilst these movements are small, the differential movement across the width of the adjoin properties could lead to cracks appearing in the walls and in the finishes. As explained in this report the scale of movement predicted could lead to hairline cracks in the walls, though many of the adjoining buildings appear to have a lime based mortar in their brickwork walls and this may be able to take up this small movement without cracking. Finishes to floors, walls, and ceilings however can be more susceptible to cracking as a result of this movement, especially brittle finishes. The Contractor will be required to carry out detailed monitoring of the adjoining properties to record ground movements, and take action should the movement not be as expected. Trigger levels have been set to identify limits on monitored results and to define actions if these limits are reached. The traffic light approach will be adopted with green, amber, and red trigger levels set. The new structure is designed to be self-stabilising and independent of party walls while providing support and lateral restraint.

In accordance with CPG4, all structures that are classified as Very Slight (category 1) and above are to receive appropriate mitigation measures to be agreed with the contractor when appointed.

10.2 Mitigation Measures

Measures to mitigate potential damage as a result of ground movements include:

1. Propping of the retaining wall during construction to limit deflection
2. Temporary works to ensure stability of existing structures, this will include to propping of the sensitive Walls O, U, and AQ identified in Appendix D – Part 3.
3. Movement monitoring and trigger levels.

Category of damage	Description of typical damage	Approximate crack width (mm)	Limiting tensile strain ε_{lim} (per cent)
0 Negligible	Hairline cracks of less than about 0.1 mm are classed as negligible	<0.1	0.0-0.05
1 Very slight	Fine cracks that can easily be treated during normal decoration. Perhaps isolated slight fracture in building. Cracks in external brickwork visible on inspection	<1	0.05-0.075
2 Slight	Cracks easily filled. Redecoration probably required. Several slight fractures showing inside of building. Cracks are visible externally and some repointing may be required externally to ensure weathertightness. Doors and windows may stick slightly.	<5	0.075-0.15
3 Moderate	The cracks require some opening up and can be patched by a mason. Recurrent cracks can be masked by suitable lining. Repointing of external brickwork and possibly a small amount of brickwork to be replaced. Doors and windows sticking. Service pipes may fracture. Weathertightness often impaired.	5-15 or a number of cracks > 3	0.15-0.3
4 Severe	Extensive repair work involving breaking-out and replacing sections of walls, especially over doors and windows. Windows and frames distorted, floor sloping noticeably. Walls leaning or bulging noticeably, some loss of bearing in beams. Service pipes disrupted.	15-25 but also depends on number of cracks	>0.3
5 Very severe	This requires a major repair involving partial or complete rebuilding. Beams lose bearings, walls lean badly and require shoring. Windows broken with distortion, Danger of instability.	Usually > 25 but depends on number of cracks	

Damage Category Chart (CIRIA C580)

11 Proposed Monitoring of Movements

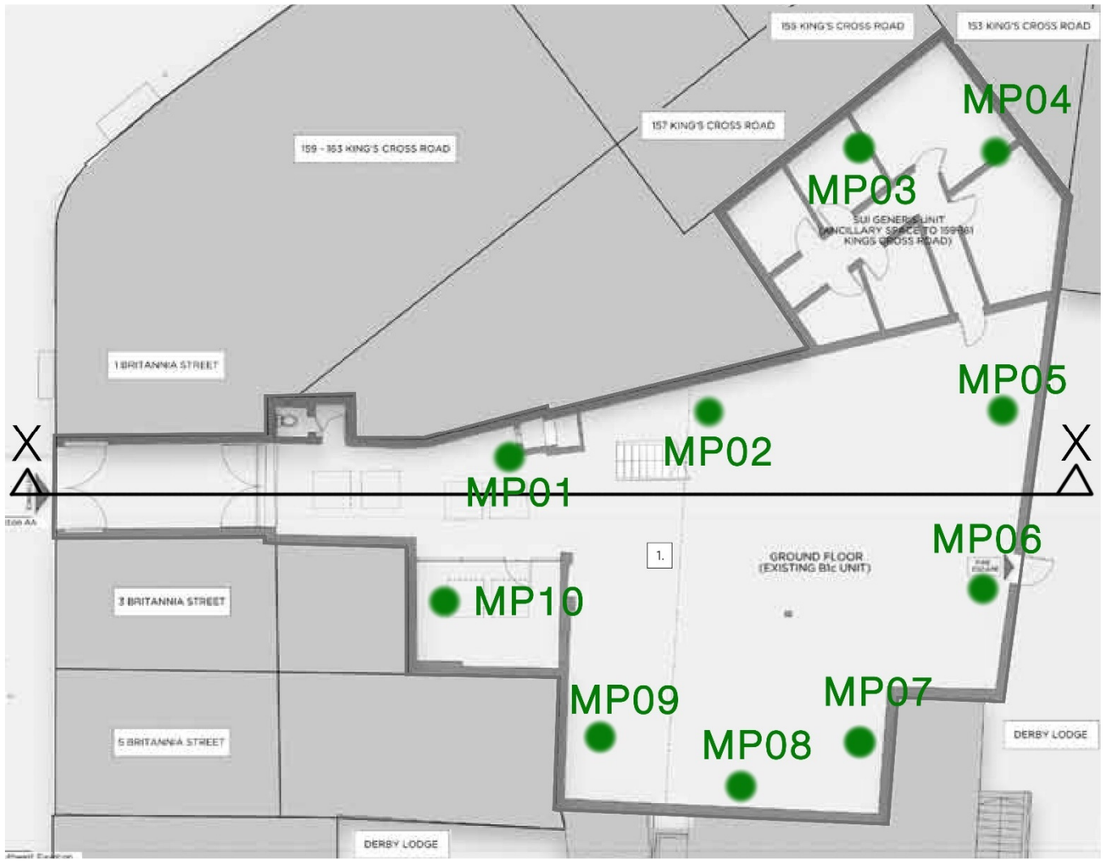
As part of the proposed works the Contractor will be required to carry out monitoring of the adjoining buildings as a check on the actual ground movements during construction. This monitoring is to include the proposals illustrated here which aim to monitor the movement of the adjoining buildings.

The monitoring is proposed to start before the main demolition works commence to help establish the baseline and record pre-construction activities.

During the works the monitoring will be aimed at recording the building movements on a regular twice weekly basis (reduced frequency as appropriate) to gauge whether the movements taking place are within the predicted and expected limits. Monitoring results are to be forwarded to the deign team for comment as soon as they are available.

If the monitoring shows that the movement exceed, or look likely to exceed, the expected figure, action will need to be taken by the Contractor to bring them under control as discussed later in the section on Trigger levels.

The proposal could involve stopping the works onsite though this is unlikely if the Contractor is proceeding carefully and diligently with the construction. All of this including an action plan for what to do if appears excessive will need to be agreed with the Contractor and reflected in their method statement.



12 Movement Trigger Levels

12.1 Movement Trigger Levels

12.1.1 Trigger levels will be used to identify limits on the monitored results and to confirm/identify actions if these levels are reached. The traffic light system will be adopted, with green, amber and red trigger levels set.

12.1.2 The setting of appropriate trigger levels is to consider the following factors:

- The amount of predicted movement
- Accuracy of the monitoring equipment
- Normal/ preconstruction movements of the buildings
- Likely damage resulting from the predicted movement.

12.1.3 The amount of movement predicted has been assessed by the GEA, and the damage resulting from these movements has also form part of their assessment. The underpinning specifications will give performance specifications for the temporary works, which limit movements and damage criteria to appropriate levels for the type and age of buildings surrounding the site.

12.1.4 The accuracy of the monitoring equipment for reading horizontal and vertical movements is to be limited to +/- 2mm.

12.1.5 The impact of normal movements of a building, such as thermal movements will need to be judged during the monitoring. The extent of this will need to be assessed during the early stages of the monitoring. To this end trigger levels will be set at monitoring points close to the ground where the effects of thermal movements are reduced.

12.1.6 Proposed Trigger Levels for walls adjacent to Walls O, U, AQ

(see Appendix D – Part 3)

The below values are based on surveying tolerances of +/-2mm.

Suggested Trigger Levels to be Agreed		
	At Competition of Basement	
Alert Level	Vertical	Horizontal
Green	<6	<3
Amber	6	3
Red	8	Q = 3.5 O and AU = 4

12.1.7 Actions to be taken by the design team and the contractor if these trigger levels are reached are summarised in the table below:

Actions		
Alert Level	Design Team	Contractor
Green	Continue to review monitoring as normal	Continue work as programmed and monitor as normal
Amber	a) Review monitoring results with contractor b) Review contractors amber action plan c) Make comments on contractors proposals and discuss with CA	Contractor to implement amber level action plan. This should include the following: a) Recheck monitoring to confirm readings b) Review method of working and highlight any activity relating to measured movements c) Propose revised methodology in to reduce trend in increasing movements d) Agree revised proposals wit CA prior to implementing. e) Increase frequency of monitoring
Red	a) Review monitoring results with contractor b) Review contractors red level action plan c) Make comments on contractor's proposals and discuss with CA d) Carry out condition survey with PW surveyor on affected buildings.	Contractor to implement his red level action plan. This should include the following: a) Stop work b) Recheck monitoring to confirm readings c) Install additional temporary works where required. d) Submit new methodology/ proposals to stop further movements. e) Agree revised proposals with CA prior to implementing f) Increase frequency of monitoring

13 Other Structural Works to the Party Walls

13.1 General

Other structural works to the party walls include:

1. Making good of the masonry party wall where existing structure built into the wall is removed.
2. Fixing/supporting of temporary works to the party wall
3. Permanent tying of the superstructure to stabilise the partywall

13.2 Making Good of Masonry Party Wall

Parts of the existing structure are built into partywalls, this includes:

1. Brickwork internal walls
2. Steel Roof trusses
3. Various fixings

As part of the proposal all of the above existing structure will be removed and the masonry made good to Architects details.

13.3 Fixing/Support of Temporary Works

External temporary works will be provided to the party wall as required.

Where feasible we have avoided fixing into party wall, but in order to provide lateral support to the party wall some fixing and temporary shoring will be necessary, these fixings into the party wall will be simple resin anchor bolts.

Temporary works drawings will be issued to the contractor carrying out the works for his information. The contractor however will be responsible for the preparation of his own proposals for temporary works for which he will remain solely responsible. The contractor's proposals shall be submitted to the contract administrator for comment prior to the commencement of the works on site, and may be different to those assumed by the Parmarbrook.

14 Stability of Surrounding Buildings

14.1 Temporary Works/Phasing

The following assumptions have been made during the design of the substructure of the building:

- Final phasing will need to be developed further by the appointed contractor and following further opening up works on site.
- Method Statements of the proposed demolition and sequencing of the temporary propping will need to agreed prior to commencement of all works, to ensure proposals do not adversely impact the structure of the retained buildings.

14.1.1 Stability of Surrounding Buildings

Stability of the surrounding buildings will be ensured both during the demolition phase and during the construction phase. This will be achieved through the following measures:

- A full ground movement analysis has been carried out by GEA, this has assessed the effect of the works. This analysis will inform the design and phasing of the works, so that a suitable temporary works design and sequence can be installed to limit damage to surrounding properties.
- All works will be carried out in an agreed sequence, working to a method statement approved by all parties.
- Movement monitoring will be installed to all surrounding properties, so that actual movements during demolition and construction can be monitored with appropriate trigger levels and precautionary measures adopted.
- Propping of the sensitive walls O, U, and AQ identified in Appendix D – Part 3 will be required to ensure that the displacement are maintained

14.1.2 Summary

The predicted ground movements shown in the report do not present a significant global stability issue for the neighbouring buildings as they are small, ground movements which may take place as a result of the works will be closely monitored and appropriate action be taken should larger than anticipated movements be observed. Temporary shoring or tying will be provided as a mitigation measure and any necessary remedial work will be undertaken.

15 Site Management

At the planning stage an early indication of the systems and processes which will be undertaken by the main contractor can be outlined. The processes ensure that the preparatory and construction work is well planned and executed, and care is taken to minimise the impacts on the surrounding environment.

15.1 General

The Contractor is expected to minimise the impact of the construction activities on the surrounding area and follow industry best practice guidelines. There are a number of mitigation measures which are listed below.

15.1.1 Airborne Pollutants Mitigation Measures

1. In dry periods the works can be damped down to reduce dust
2. Ensuring all materials are properly contained or covered with secured sheeting
3. Inclusion of physical barriers
4. Appropriate ground covering.
5. Avoid cutting down of materials where possible.

15.1.2 Noise Disruption Mitigation Measures

1. Strict adherence to site working hours
2. Avoid deliveries during peak traffic times
3. Utilise sound reduction equipment for plant

15.2 Demolition

The environmental impact of the demolition process will be reduced with a series of mitigation measures:

1. Solid site hording will be erected prior to any works to minimise dust and noise pollution, and provide security for the site.
2. Encapsulating scaffolding maintained 2m above working level
3. Demolition materials will be removed from site on a daily basis to reduce the amount of material which can generate airborne pollutants at any one time.
4. The pavement will be washed down at the end of each day with any significant amounts of particulate matter being removed as it occurs.
5. Broken out material shall we watered to reduce airborne particulates.
6. Dust monitoring
7. Traffic Monitoring with controlled, planned, and staggered deliveries/removals

15.3 Excavation

A detailed method statement will be produced by the Contractor/Subcontractor for the excavation works which will detail the measures used to provide an excavation that is stable, safe, and minimises environmental impact.

1. Solid site hording will be erected prior to any works to minimise dust and noise pollution, and provide security for the site.

15.4 Recycling, Reuse, and Disposal

Any opportunity to recycle or reuse materials made available during the demolition phase will be taken, this will include:

1. Recycles/Reuse of stock bricks, steel beams, and timbers as appropriate.
2. Separating of waste materials onsite to facilitate recycling, materials will then be taken to recycling stations where records will be produced by the recycling stations.
3. Ensuring that all Duty of Care requirements are complied with.
4. The contractor will ensure that the site is kept free from build-up of materials which are to be removed from site

16 Assessment of Flood Risk

Please refer to separate Flood Risk Assessment Document 1676_FRA_16.03.03 and its appendices.